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THE ANALYSIS OF COGNITIVE GROWTH OF CHILDREN AS SHOWN IN THEIR ORAL DISCUSSION AND WRITTEN COMPOSITIONS. FINAL REPORT.

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THIS WORK WAS TO CHECK ON THE POSSIBLE EFFECTS OF TRAINING INVOLVED IN THE CHILDREN'S DISCUSSIONS GATHERED IN PROJECT NO. 5-8344 (CONTRACT NO. OE-6-10-291), AND TO PROVIDE INFORMATION TO HELP INTERPRET THE LANGUAGE BEHAVIOR OF SOME CHILDREN OF THAT STUDY IN TERMS OF COGNITIVE DEVELOPMENTAL LEVELS. THE DISCUSSION FORMAT OF THE PREVIOUS STUDY WAS USED WITH NEW GROUPS OF CHILDREN (GRADES ONE THROUGH SIX). DISCUSSIONS OF THREE ILLINOIS INQUIRY TRAINING FILMS OF PHYSICS EXPERIMENTS WERE ANALYZED AND COMPARED WITH SIMILAR DISCUSSIONS BY CHILDREN OF THE EARLIER STUDY. ALSO, NEW FOURTH-GRADE CHILDREN FROM A NEBRASKA PROGRAM SCHOOL AND A SCHOOL WITH A TRADITIONAL LANGUAGE ARTS PROGRAM WERE TAKEN IN GROUP DISCUSSIONS OF CHILDREN'S QUESTIONS. THE BEHAVIOR OF THESE GROUPS WAS COMPARED WITH THAT OF PREVIOUS STUDY'S CHILDREN. OUR RESULTS SHOWED--(1) THAT AS CHILDREN'S GRADE LEVEL INCREASED, THE TYPES OF ANALOGIES IN TERMS OF WHICH THEY WOULD LOOK UPON THE PHYSICS EXPERIMENTS CHANGED EVEN THOUGH THE LOGICAL COMPLEXITY OF THEIR EXPRESSIONS SHOWED GREAT VARIATIONS AT EVERY GRADE LEVEL, AND (2) THAT CHILDREN WHO HAD PARTICIPATED IN OUR DISCUSSION SITUATION FOR THREE YEARS WERE QUICKER TO RESPOND TO THE INTERVIEWER'S SUGGESTIONS, WERE ABLE TO CARRY ON THE DISCUSSION FOR LONGER PERIODS WITHOUT THE INTERVIEWER'S INTERVENTION, AND EXHIBITED A FREER USE OF GESTURE IN CONNECTION WITH THEIR VERBAL OFFERINGS THAN DID THE UNEXPERIENCED GROUPS, REGARDLESS OF PROGRAM. (AUTHOR)

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Elizabeth T. Carpenter, Ph.D.

June, 1967

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The University of Nebraska

Lincoln, Nebraska

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--- E. T. C.

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INTRODUCTION

The specific need for our undertaking this research grew out of work done in connection with a three-year study which was about to enter its last year of data gathering at the time this study was begun. As part of the larger study, entitled: "The Analysis of Children's Compositions in Terms of Logical Criteria and Cognitive Theory (Grades 2-6)" (supported by the U. S. Office of Education, Contract No. OE-6-10-291), we worked with thirty elementary school children in situations in which they were to perform certain kinds of language tasks in writing and orally. These children, whom we would follow for three consecutive years, were members of a classroom whose teacher was using the Nebraska English Program, which was developed as part of Project English by the Nebraska Curriculum Development Center.

Under the larger study, these children were given writing assignments in four different situations: one, where they were to retell a folk tale in whatever way they wished; another, where they were to write an original myth; a third, where they had freedom to tell any sort of story; and a fourth, in which they were to write some kind of explanation of the events shown in a filmed physics experiment. In addition, they participated six times during each school year in an oral discussion situation, in connection with which they wrote down questions to talk about. We worked in these situations with these children during their second, third, and fourth grades in school.

In attempting to interpret certain parts of the data gathered from the written science experiment explanations and from the discussion sessions some problems arose. In order to solve them and so make the most of the data gathered in connection with the larger study, we undertook this project.

The problems, though closely related, are of two types:

1. Our children, as second graders, gave both in writing and orally several kinds of explanations for the experiment shown them in the film. That year they saw the Illinois Inquiry Training Film of the collapsing varnish can. Similarly, as third graders, they offered a variety of explanations for the film of the heated brass ball and ring experiment (another Illinois Inquiry Training Film). And when they were shown the film -- from the same series -- of floating and sinking blocks of wood in the fourth grade, even more variety appeared in their offered explanations.

Now, with such a variety of explanations occurring at each grade level and with no body of research on this matter to fall back on, how are we to tell what sorts of explanations are characteristic of children younger than our group and what sorts are characteristic of older children? In short, we must have information from many more children at neighboring age and grade levels with which to compare the group being studied longitudinally.

2. During the second year of the larger study certain types of behavior in the discussion sessions were noted about which we could not tell whether they occurred as a result of the children's natural rate of growth, the result of their having worked under the Nebraska Program, or the result of their regular participation in the discussion sessions. Thus, the need was felt to take fresh groups in order to solve this problem.

Here are some of the things we noticed about their behavior during their second year of participation in the discussion sessions (their third grade): (a) none of the children hesitate to speak; (b) their verbal responses often take the form of "thinking out loud" about the matter under discussion; (c) when a child offers a suggestion or comment, or gives his explanation of the science experiment, he usually offers it first in short form -- in the case of the experiment explanation he says exactly what he had previously written -- but immediately proceeds to explain himself, without being asked to do so; and (d) when requested by the interviewer to think how they might find out the

answer to a given question without looking in an encyclopedia, the children have become less hesitant to use their imagination openly and inventively than they were during the first year of discussions.

The next year (when the children were in the fourth grade) we found other things occurring during the discussion sessions: (e) the children have come to carry on the discussion in a fairly orderly manner for as long as five minutes at a time without the interference or interjections of the interviewer; (f) their use of gestures in connection with explaining has become much more free than in the previous years; (g) cases of their offering to draw pictures and diagrams to help show what they mean has become commonplace in discussions of the physical world; (h) their critical remarks on a fellow's suggestions are commonly framed in terms of the consequences if the suggestion were right -- in these cases, a child's steps in reasoning are made explicit and with some children the use of transitive implicative series emerges clearly; and (i) the span of time used for discussion of a given question has increased from five minutes at second grade to forty minutes at fourth grade.

Arising out of our work with these children in the discussion sessions is another question, the answer to which is important from an educator's point of view. That is: Does the children's observed lack of hesitation in speaking within the small group discussion situation carry over into a larger group situation and without the familiar interviewer present?

METHOD

Procedure. The children used in the discussion sessions, with which our new groups are to be compared, were taken from their regular classroom into another room in the school building for these sessions six times during the school year. The usual time interval between sessions was two weeks, and the usual length of each session was 40 minutes. The children participated in groups which were coincident with the reading ability groups with which the teacher worked in the classroom. There were three groups; each group consisted of 8 to 11 members.

In general the groups differed from each other in reading ability -- that is, according to norms reported by the publishers of the readers used at the fourth grade level here, our "high group" placed on the readers tests at least 6 months beyond the average for their grade level; the "middle group" from 3 months below to 5 months above the average; and the "low group" at least 4 months below average for their actual grade level. Differences between the groups were not so pronounced or clear-cut in IQ scores (based on the CTMM). The "high group" represented IQ scores ranging from 110 to 132; the "middle group" ranging from 98 to 115; and the "low group" ranging from 87 to 110.

In connection with the discussion sessions the children kept folders which we called Question Books in which they entered questions they wanted to ask. These Question Books were collected on the school day preceding a scheduled discussion with a group. Entries were transcribed for our records. And at the beginning of the session Question Books were returned to their owners.

Participants were seated around a table on which a microphone was placed so that the ensuing discussion would be taped, later transcribed and studied by the interviewer.

For the first five sessions during the year the discussions took the following format: (1) a child was called on to select from his written questions one that he would like to talk about; (2) when the child had stated his question, he was asked how he happened to ask that question -- in order to get some background for the child's concern with that question; (3) the child was then asked how he might go about finding out for himself the answer to his question -- this gives the interviewer some notion of how the child understands his question and what he finds relevant to its answer; finally (5) other children in the group were asked to give their suggestions as to the way they might find out the answer to the same question.

In the sixth discussion session of the year, which was held after the children had seen the Illinois Inquiry Training Film and written out their explanations, the interviewer began by reviewing the film. Then each of the children were asked to explain why the experiment shown in the film turned out the way it did.

It should be noted at this point that in none of the sessions did the interviewer answer the child's question for him. Neither did she correct the child's answers. The main purpose of the discussion is to give the child opportunity to express his own ideas so that others may understand them.

For the sessions with the new groups of children used to supply information toward the solution of Problem 1 (see p. 2, above), the interviewer used exactly the same procedure as described for discussion of the filmed science experiment, with one exception: the children had not beforehand written out their explanations. Discussion sessions held in pursuance of Problem 2 (see pp. 2-3, above) the usual Question Book discussion procedure was used; and the new groups of children had been given Question Books in which to enter their questions.

The Sample. The children used for this study were chosen in such a way as to duplicate at each grade level and with each ability group some of the same factors as were present with our three-year group.

For example, wherever possible a discussion group was comprised of children from the same classroom who were accustomed to working as a group for their reading lessons. The only exceptions to this occurred where class reading groups were either so small or so large they would not have made up a discussion group of size comparable to our three-year groups. In such a case, we merged or split class groups into discussion group(s) of the right size, providing that their range of IQ scores and reading abilities would then be comparable to the range represented in the corresponding group of the three-year children.

The size of the new discussion groups used in connection with Problem 1 ranged from 7 to 15 children in the "high group", from 7 to 11 in the "middle group", and from 6 to 12 in the "low group". Thus, in several cases these groups differed in size somewhat from those of the three-year groups. We elected, however, to use them anyway. For had we insisted on taking groups of exactly the same size as our three-year groups this would have meant making more artificial divisions within the class and perhaps forcing together in discussions children who were not so accustomed to working together.

The size of discussion groups used in connection with Problem 2 was the same as corresponding three-year groups.

All groups, with the exception of one "high", one "middle", and one "low" group, had not been subjected to the Nebraska Program and were made up of children from the population of the same school as our three-year groups.

For the sake of the writer's convenience, and hopefully, the reader's peace of mind, through the remainder of this report we will refer to our three-year groups as "Ex-groups", to the new groups used in pursuance of Problem 1 as "DC-groups", and to the new fourth grade groups used in connection with Problem 2 as "BC-groups".

DC-groups at each grade level were participants in discussions of the three Illinois Inquiry Training Films that our Ex-groups had discussed during the three years of the larger study. We used the films as follows: "high" DC-groups were shown the film of the varnish can

experiment and discussed why the can collapsed; "middle" DC-groups saw the film of the floating and sinking blocks of wood and discussed why one object floats and the other sinks; "low" DC-groups viewed the film of the brass ball and ring experiment and discussed why the ball stuck in the ring and then why it later fell through the ring.

Methods of Analysis. Complete typed transcripts were made of the taped DC-group discussions. Notes were then made of what explanations were offered by members of each group at each grade level. These explanations were compared with those which had been offered in writing and orally by children of the sample of the larger study. We counted the number of times each explanation occurred at each grade level in the discussions and then mapped out which explanations were characteristic of what grade levels. This was to be used as our key to the problem of deciding where the explanations given by the larger study sample might be said to fit on a scale of cognitive growth with regard to the physical causality notions elicited by the filmed science experiments.

The tapes of the discussions held with BC-groups were analyzed in the following ways: (1) the number of group members who made contributions of any sort in language was counted; (2) the length of time spent by the group in discussing one question was noted: (3) the length of time between the interviewer's calling on a child and the child's first utterance; (4) the length of time between each of a series of utterances made by child uninterrupted by utterances of other children; (5) the number of offerings in a series made by different children uninterrupted by the interviewer; (6) the length of time taken by the series noted in (5) above; (7) instances were counted of critical remarks made that were framed in terms of the supposed consequences of a suggestion's being right -- special note was made of occurrence of such remarks spontaneously, without the suggestion of the interviewer; (8) we counted instances of imaginitive responses to interviewer's request for children to "suppose you were going to write that book" after child has said he would find out the answer to the question by looking it up in a book -- also time lapsed between interviewer's request and child's imaginitive response was noted.

Also, immediately after each discussion session with BC-groups, the interviewer noted from memory the children who had freely used gesture in connection with their offered explanations as well as cases of offers to draw diagrams or pictures to help explain.

All this information was then compared with similar notes made on the last session held with each of our Ex-groups.

As to the question mentioned above (see p. 3) regarding the possible carry-over of behavior patterns exhibited by the Ex-groups into a discussion situation involving a larger group without this interviewer being present; we expressed our wonderings about this to an administrator of the school in which the Ex-groups were enrolled. She graciously arranged with the teachers of all fourth grade children in the school to have all their children gather in the school auditorium to hear a lady talk about putting on a play the children had all seen the week before. After she talked to the children for about ten minutes, she used some of the children to demonstrate certain problems that arose in producing the play -- this demonstration lasted for about eight minutes. Then for twenty-two minutes the children were given opportunity to ask her questions and to make comments. During this discussion period,* the teachers tallied language contributions made by each child assigned to her classroom. From these tallies, we calculated the percentage of the total contributions made that came from children of our Ex-groups. We also kept reference notes on where in the auditorium our groups were seated in relation to other fourth grade groups.

*That is, during the thirty minutes in which the children participated.

RESULTS

Re: Problem 1. The following is a summary of the data gathered from "high" DC-groups in discussion of the question: "Why did the varnish can collapse?"

1. Explanations involving the notion that the can melted or softened, either from the fire of the burner, from the steam inside the can, or from the water poured over the top of the can, occurred at every grade level from 1 through 5 (None occurred at grade 6.) but was most common at grades 1, 2, and 3 where it was the most used explanation of all that came up.

2. The simple explanation: "hot and cold don't go together;" occurred quite often at grade three. It did not come up in discussions at any other grade level.

3a. The mere separation of the hot water inside the can from the cold water outside was given as the causal factor in grades 1 and 2 only -- at those levels it occurred with less than one-fourth the frequency of "melting"-explanations, and sometimes was given in conjunction with these explanations.

3b. The separation of steam inside from cold water outside the can came up in explanations given at grades 3 and 4 only. At neither level was this the most common explanation offered. At grade 3 it was usually given in conjunction with a "melting"-explanation.

3c. Explanations, in which the separation of steam or hot air within the can from cold water outside the can was given in conjunction with the notion that the can was corked, not to keep cool air outside from entering the can, but to keep the hot air or steam inside the can from escaping -- these explanations occurred at every grade level but the fifth, and in

grade four it was partially expressed in mythical terms (the steam inside the can was personified -- it "wanted to come out" by two children.

4a. At grades 3 through 6 children offered explanations involving the notion that the mere meeting of opposing elements was the chief causal factor. The characteristic expression used was "warm against cold makes it happen."

4b. Specific elements -- cold water, hot can -- meeting was the characteristic notion involved in explanations which occurred at every grade level (1 through 6), but most commonly occurred at levels 4, 5, and 6.

4c. Water meeting a can that was "so hot" was an explanation which occurred only at grade 4 in our discussions. At that grade level it did not occur with any great frequency.

5. At grades 5 and 6, with some frequency arose explanations involving the use of the cork in the can to keep air from getting inside plus the notion that a "suction" occurred either from inside or from outside that caused the can's collapse.

6. The isolation of one or two of three correct causal factors: the separation of inside from outside factors; the designation of the inside factor as steam or hot air; and the cooling of the inside factor from outside the can: arose only at grade 6 with any frequency. However, the mention of all three of these factors occurred only in the explanations of two children -- one at grade 3 and one at grade 4.

7. Explanations in which a change was said to have occurred in the can itself were given by children in grades 1 through 6, but were most common at grades 3 through 6 and in the following forms: "Heat made the can weak and cold water on a weak can makes it collapse" -- most common at grades 3 and 4; "The can was hot and then cold, quickly" -- grades 4 through 6; the latter expression plus an explicit analogy with glass breaking -- at grades 4 and 6.

8. Simple explanations in which the "pressure" -- that is, the weight -- of the water being poured on the top of the can was said to have caused its collapse

occurred from grades 3 through 6 but was most common at grades 3 and 4 and then coupled with some form of (7) above.

9. The simple explanation: "the can had steam in it;" occurred only at grade 2 and there it was expressed by only two children.

10. Explanations which somewhere fit the scientific explanation outlined in the manual accompanying the films were offered by children in grades 4, 5 and 6. However, only at grade 6 was a complete scientific explanation offered, and then only by one child. Others whose offerings fit the scientific key left out any indication that a notion of atmospheric pressure was involved in their thoughts.

Analysis of the "middle" DC-groups' discussions about the filmed experiment in which two blocks of wood are first weighed and then placed in a glass tank of water -- the heavier (pine) block floats and the lighter (ebony) block sinks to the bottom of the tank -- yielded the following results. (The question put to the children was, "Why does one object float while the other sinks?")

1. The notion that one block sank because it had absorbed water, or became waterlogged, and as a consequence became heavier, appeared in a few explanations offered at grades 3, 4 and 6. These did not occur with any great frequency.

2. The use of an analogical model of a boat filling with water appeared, along with the notion that the sinking block had holes in it which filled up with water and thus sank as a boat would sink, at grades 1, 3, 4 and 6, but was most common at grades 4 and 6.

3. Extremely prevalent was the notion that the water got on top of the thin (that is the ebony) block and forces it to sink. This explanation occurred at every grade level except grade 2. It was most common in grades 3 through 6, where children usually added that, if the water could have gotten on top of the larger (pine), block it would have sunk, too.

4. The combination of size and shape was given as the causal factor by children at every grade level

except grade 2. This explanation was most common at grades 3 and 4.

5. Size alone was said to be the causal factor by three children at grade 1.

6. Only at grades 3 and 5 did children give the notion that there was some kind of substance in one block that was not contained in the other block. These notions were not frequent, however.

7. The difference in the kinds of wood, in that one was hardwood and one softwood, was singled out as a causal factor in the experiment by just three children at grade 4.

8. The difference in the kind of wood of which the two blocks were made was said to have affected a difference in their weights and their hardness such that one sank and the other floated, was offered as explanation by only two children at grade 4.

9. The difference in the kind of wood affecting a difference in their weights was given in explanations offered by several children at grades 5 and 6 only.

10. A combination of the shape and weight only was given as causal factor by a great proportion of children at grades 3 and 4.

11. The weight of the blocks was considered the only causal factor by the overwhelming majority of children in grades 1 and 2, and was offered by some children at grades 3, 4 and 5.

12. A combination of the size, weight and shape of the blocks was mentioned as the causal factor by several children at grades 4, 5 and 6. These were not further explained, however.

13. The combination of just weight and size was said to be the causal factor in the experiment's results by a few children ranging from grade 1 through grade 6.

14. Two children at grade 3 thought that there was something like paint on the ebony block that made it heavier and caused it to sink.

15. At grade three, there were two children who said that air in the pine block made it float. A similar explanation was offered by two children at grade 6, also.

16. Only at grades 5 and 6 did an explanation arise which involved the notion that the blocks' weight in water was different from their weight on the scale -- that the block that is heavier in water is the block that sinks. These were not offered by more than two children at each of these grade levels, though.

17. "The water held it /the pine block/ up" was the only explanation offered by one child at grade 4.

18. The simple remark that "pressure did it" was given by one child at each of three grade levels: grades 3, 4, and 6. This was abandoned by each child when interviewer asked him to explain what was meant by the word, pressure.

19. "The big one just wanted to float" was the explanation given by one child in grade 1.

Light things can float down or stay up "if they like" was the one given by one child at grade 5.

These explanations we consider to involve mythical elements since they work upon the personification of the wood blocks.

The following explanations showed up in our analysis of the "low" DC-groups' discussions on the brass ball and ring experiment, in which the children considered the questions: "Why did the ball stick in the ring (after it was held over the flame for awhile)" and "Why did the ball later fall through the ring?"

1. Only in grade 1 did an explanation containing mythical elements appear. It was in the form; "the ball didn't want to go through, and then it just fell through." The child who offered this later went on to suggest that the ball got sticky in the fire, melted, and then stuck to the ring.

2. The idea that the ball melted and got sticky and/or that the ring did so appears at each grade level (1 through 6), although in grade 6 it was

ordinarily coupled with the notion of a change in size of the ring or in the size and weight of the ball due to heating and cooling. The incidence of the "melting" explanation decreases considerably during 5th and 6th grades.

3. Explanations involving a "magnet" model occur only in grades 3, 4, and 5; being most frequent in grade 4. In every case in which the "magnet" notion appears it is accompanied with a singling out of heat as the factor causing the magnetic effect which "wears off" or "lets go" as cooling takes place. Also, in 5th and 6th grades primarily, those explanations involving the heat-caused magnetism commonly included some reference to either a change in weight of the ball as an additional effect of the heating or a change in the effect of the gravity on the ball, and/or a difference in the height from which the ball was dropped after it was heated -- the latter, when it appears, is taken by the child as the chief factor whether or not the "magnet"-notion remains (i.e., even when the child says that maybe magnetism is not right).

4. The bare beginnings of a concept of the conduction of heat is shown in grade 4 once and even there it is coupled with a suspicion that ring size was changed through some unseen act of the experimenter (i.e., that some sort of trick was perpetrated). However, at grade 6 the statement: "the ring expanded," occurs twice -- in just one of these 6th grade cases the accompanying expressions indicate that the notion of heat conduction is probably present, at least in some vague form. Nowhere in all the data gathered from the children in this study does the word "conduct" appear in any of its forms.

5. The expressions: "burnt its way out" and "pushed its way through," occur in those 6th grade explanations involving ring changes due to the hot ball.

6. The partial explanation that the ball expanded in the heat from the flame occurs at every grade level, though its incidence at grades 1 and 2 is quite low and occurs in conjunction with the notion that the ball got "sticky" and/or with the suggestion that the experimenter tricked the audience by exchanging balls or by manipulating the size of the ring. At grade 3 four out

of the six children offering "expanded" in their explanations went on to explain their use of the word in terms of an analogy with a balloon being blown up. This "balloon"-analogy occurs only once more, outside grade 3, and then in grade 5.

7. From grade 4 on through grade 6 the incidence of the explanation that the ball expanded and then later contracted relative to heating and cooling, respectively, is greater than at any other level. In grades 4 and 5, it is still coupled with notions of "sticky" and "melting" or "magnetism;" but in grade 6 there is less occurrence of these configurations and more explication citing <u>air</u> in the room as a cooling factor and of the hot ball's effect on the ring.

Re: Problem 2. The results of our analysis of data gathered from the BC-groups is summarized as follows: (All averages given for each group represent the average for the three ability groups -- "low," "middle," and "high" -- used from each program.)

1. The total number of group members making language contributions in relation to the number of children in the three ability groups were:

Ex-groups	25 out of 25
BC-groups (Neb. Prog.)	27 out of 33
BC-groups (trad. prog.)	25 out of 30

2. Average length of time spent on one question:

Ex-groups	40 minutes (all time allotted)
BC-groups (NP)	39 minutes (all time allotted)
BC-groups (tp)	33 minutes (out of 40 minutes)

3. Average time lapsed between interviewer's calling on a child and the child's first utterance:

Ex-groups	less than 3 seconds
BC-groups (NP)	5 seconds
BC-groups (tp)	4 seconds

4. Average time lapsed between each of a series of a child's utterances, uninterrupted by another speaker:

Ex-groups	less than 3 seconds
BC-groups (NP)	about 3 seconds
BC-groups (tp)	about 5 seconds

5. Greatest number of offerings in a series by different children, uninterrupted by the interviewer:

Ex-groups	12 (average for three ability groups
BC-groups (NP)	4 (average for three ability groups
BC-groups (tp)	2 (average for three ability groups

6. Average of time taken up by series (in #5, above):

Ex-groups	1 min. 22 seconds
BC-groups (NP)	18 seconds
BC-groups (tp)	18 seconds

7. Average number of instances of remarks framed in terms of consequences of a fellow's suggestion being correct:

Ex-groups	13
BC-groups (NP)	3
BC-groups (tp)	3

8. Average number of imaginative responses to "suppose" requests of interviewer; and average time lapsed between request and response:

Ex-groups	7	less than 3 seconds
BC-groups (NP)	9	9 seconds
BC-groups (tp)	6	15 seconds

9. Total number of children in the three ability groups using gestures freely and/or offering drawings to help explain:

Ex-groups	23 out of 25 contributors
BC-groups (NP)	14 out of 27 contributors
BC-groups (tp)	11 out of 25 contributors

With regard to the question of whether experience in the discussion situation for three years might have effected our children's willingness and quickness to make language contributions in a larger group situation where this investigator was not the interviewer, our data indicated the following:

Of the 117 fourth graders present at the large group session (thirty minutes of which was devoted to children's discursive participation) 30 were from our Ex-groups. Thus, Ex-group members comprised 25.6% of the total number of children present. 40% of the Ex-group members present made language contributions during the session; as compared with 36.8% of non-Ex-group members. 30.4% of the total number of children making contributions were in the Ex-groups; while of the total number of language contributions made during the session, 23% came from members of the Ex-groups.

Note: Seating arrangements in the auditorium were such that all but five Ex-group members were neither in front nor in back of the auditorium -- they sat about halfway back; a whole classroom of children was in front of them and another in back of them. Five Ex-group members sat in the front on the speaker-interviewer's left -- of those five, however, only two made language contributions, one each, during the session.

DISCUSSION

The results obtained from analysis of our DC-groups' discussions of the filmed science experiments were a help in putting into some perspective the written explanations given for the same films by the children in the sample of the larger study. We must emphasize at this point, however, that they serve only with respect to the children's notions about the phenomenon of these experiments, and we do not intend to apply them further. We have not repeated statistical calculations to see if, among the results from these discussions combined with results from the larger study's Situation V written explanations, there is a correlation between the children's IQ scores and/or their grade levels and the type of explanation given for each experiment. Scanning the relevant scores for the DC-group members has shown us that probably the same lack of correlation would be found as we noted in the larger study. Hence, we are still inclined to think that the type of explanation the children are apt to give is not directly related to the factors measured by the IQ tests we administered, or else there is sufficient overlapping of logical habits and abilities to make such calculations futile for the age range with which we are here concerned.

The comparisons we made between the elements of behavior looked for in the BC-groups from the Nebraska Program, those from the traditional language arts program, and children of our Ex-groups, are striking and perhaps useful with respect to items 6, 7, and 9 (see pp. 16-17, above). We believe these items to be a reasonably good measure of the kind of results which are forthcoming from the Ex-group children's experience in the discussion situations for extended periods.

With regard to item #8 (see p. 17, above), it should be obvious that the quickness with which children are apt to respond to the "suppose"-request of the

interviewer will always depend to some extent upon the question under discussion. During this year, there were sessions with the Ex-groups in which children took as long as 20 seconds to respond to the interviewer's request. But it happened that in the last Question Book discussion session of the year (which is the one we used to compare with our BC-groups) the children were quicker than that.

Further it should be noted that our results from these discussion sessions with the Ex- and BC-groups do not mean that the quality of the remarks made by Ex-group children were any higher than those made by children of either of the BC-groups. We have merely shown quantitatively that Ex-group children had learned the game of discussing and had played that game with less formality and more enthusiasm than most of the BC-groups did.

The results of tallies of the large-group discussion of which Ex-group members were a part are not startling. Apparently these children did not participate very differently than children who had not had the experience of repeated discussion situations.

Note: In these tallies, what were counted as "language contributions" to the discussion were those utterances of the children that were recognized by the speaker-interviewer. "Wow," "oh," and "ah," etc. were not counted by the teachers in their tallying of language contributions.

CONCLUSIONS AND IMPLICATIONS

Our analysis of DC-group discussions on the science films have shown that no definite scale can be made of our children's explanations in terms of complexity in their explicit logical movement which would be useful at this time. What does show up quite clearly, however, is a shift from analogical model to analogical model as grade level increases. And definition of these models may well be the type of key needed to understand our children's cognitive growth within the elementary school years (age 7 through 13). These are the years in which Piaget found the average child operating within some sort of system with respect to notions of physical causality -- they are the interim years between mythical, artificialistic views of the physical world prevalent in his preoperational stage of development and the more comprehensive, generalizeable views of which the child is capable when he reaches the stage of formal operations.

Taking Piaget's work on this as a stepping-off point one would expect our children to exhibit in their discussions of physical phenomenon some oscillation between the more mature views and the childish views. Our data may be showing the effects of such oscillation, since the explanations we received of the ball and ring experiment are different in important respects from those of the varnish can experiment. In both these experiments the properties of heat, metal, and air all play a part. Yet the same children (in writings) offered quite different explanations of the two experiments -- explanations in which they brought to bear different factors.

In our discussions, it became apparent that along with the different explanations came different analogies -- analogies which appeared in much the same forms in the works of different children. Thus, it would seem that the shaping of the child's view of the phenomenon at hand was done in accordance with the

models that struck him, rather than with the character of the materials and events he saw.

In the child's ideas about the varnish can experiment, apparently these analogical models hold sway during the elementary school years:

First, a view of the can's collapse as a case of melting;
Next, a view of the steam inside the can as a active substance which is trying to get out;
Later, a view of the can as directly similar to a glass which the child has noticed breaks under certain conditions.

Although, it did not happen often at any given grade level, we noticed that, in about the same age range where the glass-analogy was being offered some children made an analogy between the can's collapse and a person's fainting under conditions in which there was a rapid change of temperature from one extreme to the other.

When the children discussed the experiment involving the heated ball and the ring, the following analogies occurred with considerable frequency at different grade levels, so that apparently there are steps in the children's views in accord with the models selected:

First, viewing the placing of the ball over the flame as a case of melting the ball to make it sticky;
Next, heating the ball is seen as a way of melting the ball to change its shape;
Then, viewing the heated ball as a magnet;
Later, viewing the expansion of the ball as like the expansion of a balloon when it is blown up.

In their explanations of the wood blocks experiment, only two analogies occurred with any great frequency and they appeared primarily at grades 3 through 6:

First, the sinking block was seen as a case of a leaky boat (or container) filling with water;
Later and often coincident with the boat analogy, viewing the floating block as a case of a balloon or air-filled ball which stays afloat in water.

Conspicuously absent from the children's discussions on the varnish can and the wood blocks experiments was any acknowledgment of forces at work other than those which are taken to have their sources within the objects of the experiments themselves. For example, atmospheric pressure does not come into their methods of conceptually handling these two experimental phenomenon. Similarly, the possibility that the water in the tank (re: the wood blocks experiment) may be exerting an upward force against the blocks does not come in -- except in a very few upper grade children's explanations.

Further, what would be regarded by an adult as "self-contradictory explanations" were given without hesitation by enough of our children in grades 1 through 3 to make it obvious that Piaget's experience with this childish habit is well founded. For a considerable number of our children said that the pine block floated because it was heavy and that a piece of metal would sink because it was heavy. At third and fourth grades some children who had said this, showed puzzlement once they'd expressed it and immediately took back that explanation. The younger children (who answered thus without hesitation or puzzlement) evidently saw nothing wrong with such a conjunction of expressions. Therefore, we suggest that they viewed the two blocks as so distinct that applying similar principles to an explanation of both blocks did not even occur to them. Further, when the interviewer pointed to the two (opposing) explanations and asked these children if they were all right, the children showed no problem with their conjunction.

With respect to the high proportion of explanations in which the children used the word, melt, in connection with the two experiments involving metal objects, we must conclude that their ways of viewing the two sets of circumstances are not only different from the way we would expect an adult to look at them but they are different in important respects from one another. In the case of the varnish can, it seems that all we can take the child who says "the can melted" to mean is that the can's shape changed. Whereas, in the case of the ball and ring, "melting" sometimes involves getting sticky and sometimes involves changing shape. In any case, it would be a grave mistake to try to read into these children's expressions ideas that involve the

distinctions and discrimination which are part and parcel of adult views.

Here, as in the data gathered from the larger study, there are numerous instances of the child's use of ordinary linguistic forms as suggestive models for his own concrete analogies. "The ball sticks in the ring" was often changed to "it sticks to the ring" and in connection with that the magnet model and the gluey-sticky model are readily available. "The can collapsed" was often connected with an expression such as "the person collapsed," thus readily connected with "it can't get enough air" and "it couldn't stand it".

Until the child's view of the phenomenon of each of these experiments becomes sufficiently abstracted and generalized out of the specific objects and circumstances of the experiments, there is no reason to believe that he can work effectively with scientific principles. That does not mean, however, that he cannot parrot the words given him by adults in connection with a given set of phenomenon. Hence, teachers could be easily misled by the child's facility in verbalizing such principles at the "right time", so to speak, if no effort were made to get the child to engage in some overt activity in conjunction with his verbalizing. The extent to which children learn the language used within a context without relating that language to the proper activities or events has been born out time and time again by the results of this study as well as those of the larger study. When pressed for further explanation of the terms of that language in our free and open discussion sessions, the child who is not at home in it would drop the language and use terms he could work with clearly. We feel that forcing the child to use the language he is not at home with merely forces him to regurgitate to satisfy the teacher and does not help him to understand in any way.

The effects of participation in our regular discussion situation have shown themselves in the increased ability of the discussants to engage in an exchange of views and to entertain the consequences of a child's view. The possible implications of this for elementary education procedures should be obvious. For by using open discussion in the classroom in such a way that children are encouraged to express their own ideas as clearly as they are able, the teacher

puts himself in an excellent position to view the child's reasoning habits and thus to see the ways in which the child assimilates the material given in the classroom. Certainly, the teacher must have some knowledge of these in order to reach the child, to teach effectively.

The primary force of our conclusions in this study stands as an underscoring of the implications of the larger study. Therefore, we refer the reader to the Recommendations section of the larger work. (See pp. 29-30 of the Final Report of Project No. 5-8344, entitled: "The Analysis of Children's Compositions in Terms of Logical Criteria and Cognitive Theory (Grades 2-6)".)

SUMMARY

This work was undertaken in order to provide a check upon certain facets of data collected in connection with a study of elementary school children's writing and to provide information to aid in interpreting the language behavior of some of the children of that study in terms of cognitive developmental levels. The larger study, entitled: "The Analysis of Cognitive Growth of Children as Shown in Their Oral Discussion and Written Compositions", was supported by the U. S. Office of Education under Contract No. OEC-3-7-068713-0277.

In this study, fresh groups of children (grades 1 through 6) were taken in discussion situations comparable to those used in the larger study. The data gathered in these discussions were compared with those collected from the larger study in order to:

1. define levels of conceptual behavior in the explanations given for three filmed physics experiments which were shown the children;

2. measure the effects on a segment of the larger study's sample of regular participation in a free and open discussion situation over a period of three years (spanning the children's second, third, and fourth grades).

3. see if there was a carry-over in these children's willingness to make language-contributions in the small group discussion situation to a larger group situation with a stranger acting as interviewer.

The results of this research showed:

1. that as children increased in grade level (from 1 through 6) in elementary school, the types of analogies in terms of which they tended to look upon the viewed experimental phenomenon changed even though

the logical complexity of their expressions showed great variations at every grade level;

2. that children who had participated for three consecutive years in our discussion situation behaved differently from those who had not so participated, particularly, in that the experienced groups (a) were quicker at responding to the interviewer's suggestions, (b) were able to carry on the discussion for longer periods without interference or interjection by the interviewer than were the other groups, and (c) exhibited more free use of gestures in connection with their verbal offerings than did the unexperienced groups;

3. that there was no significant difference between the number of language contributions made by children of our discussion groups, and the number made by other children when all were placed together in a large group for discussion with a stranger acting as interviewer.

The results of our analysis with respect to the comparisons made of the experienced groups with the unexperienced groups in small-group discussions show beyond a doubt that use of the discussion situation is especially valuable for developing children's ability to handle language discursively and imaginatively. And thus it may be useful for the teacher as a way of "finding the match" by which to reach the child effectively in presenting new material.

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15. ABSTRACT *(250 words max.)* This work was to check on the possible effects of training involved in the children's discussions gathered in Project #5-8344 (Contract # OE-6-10-291); and to provide information to help interpret the language behavior of some children of that study in terms of cognitive developmental levels. The discussion format of the previous study was used with new groups of children (grades 1 thru 6). Discussions of three Illinois Inquiry Training Films of physics experiments were analyzed and compared with similar discussions by children of the earlier study. Also, new 4th grade children from a Nebraska Program school and from a school with traditional language arts program were taken in group discussions of children's questions; the behavior of these groups was compared with that of previous study's children. Our results showed: 1) that as children's grade level increased, the types of analogies in terms of which they would look upon the physics experiments changed even though the logical complexity of their expressions showed great variations at every grade level; and 2) that children who had participated in our discussion situation for three years: a) were quicker to respond to the interviewer's suggestions, b) were able to carry on the discussion for longer periods without the interviewer's intervention, and c) exhibited a freer use of gesture in connection with their verbal offerings than did the unexperienced groups -- regardless of program.

16. RETRIEVAL TERMS *(Continue on reverse)*

17. IDENTIFIERS
Illinois Inquiry Training Films;
Nebraska Program; Project # 5-8344

Figure 3. ERIC Document Resume